Agile Iterative Reservoir Modelling

SIS Forum 2019
Mark Baker
Subsurface Technology Lead
Disclaimer and important notice

This presentation contains forward looking statements that are subject to risk factors associated with oil and gas businesses. It is believed that the expectations reflected in these statements are reasonable but they may be affected by a variety of variables and changes in underlying assumptions which could cause actual results or trends to differ materially, including but not limited to: price fluctuations, actual demand, currency fluctuations, drilling and production results, reserve estimates, loss of market, industry competition, environmental risks, physical risks, legislative, fiscal and regulatory developments, economic and financial market conditions in various countries and regions, political risks, project delay or advancement, approvals and cost estimates.

All references to dollars, cents or $ in this presentation are to US currency, unless otherwise stated.

References to “Woodside” may be references to Woodside Petroleum Ltd. or its applicable subsidiaries.
The Subsurface Interpretation Challenge

Many months

Limited realisations, limited integration, linear
The Subsurface Interpretation Challenge

Project Description

Seismic Interpreations

Structural Models

Structural Grids

Stratigraphic Models

3D Petrophysical Models

Dynamic Models

Interactive Automated Insights

< 1 day to insight from 1000s of realisations
Agile Iterative Reservoir Modelling

Woodside worked with Schlumberger to explore what is possible with the new technology behind DELFI and show the power of openness for reservoir modelling

Objectives:

• Build an assisted reservoir modelling application to:
  • Reduce reservoir modelling cycle time
  • Enable collaborative, iterative working styles for integrated teams
  • Improve information for decision-making
  • Unlock subsurface and production data for next-level analysis

• Explore the flexibility and openness of DELFI by developing a new tool inside the DELFI environment

• Enable assisted quality control at each step to build trust in the process
Agile Iterative Reservoir Modelling

Parallel Petrel and Intersect processes

DELFI web app

Woodside Analytics Engine

Spotfire

Data Ecosystem

Custom Databases

DELFII Stores
Greenfield Development Application

Objective: field development insights with focus on subsurface uncertainty

• Full modelling workflow from seismic interpretation to simulation
• Incorporated Schlumberger’s seismic interpretation and static model automation
• Quality control incorporated at all steps – tracked throughout process using Data Ecosystem and viewable on Spotfire
• Process is automated and highly parallelisable
Automated Structural Modelling

Courtesy of Schlumberger
Automated Static Modelling
Assisted QC

- Fault throw consistency
- Problem cell hotspot map
- Well section
- GIIP map
- Facies proportion map
- Model cross-section
Automated Static Modelling

Version 2
Please load the workflow metadata file before doing anything.

static_modeling_workflow_params.txt

Iteration
Iteration id
9
4c357da6-0604-4548-7e91-a209b1c1c489
Start date
Mon Jun 25 2018 10:05:28 GMT+0100 (British Summer Time)

Workflow sequence
Name
WorkflowSequence1

Flowworks
Select all

Select the workflow that will be run during the realisations.

Workflow data

Variable Context Description Type Value Uncertainty (mean, sd)

Realisations
Automated Static Modelling
Objective: field development insights from appraisal well test

- Integrated subsurface team identified 36 uncertainties from seismic interpretation to spatial distribution of facies to aquifer strength
- 15 complete iterations in less than a week – each iteration 50 to 100 reservoir models from seismic to simulation
- Process allowed different hypotheses to be robustly tested within an hour
- Twice daily meetings with integrated subsurface team to examine results, discuss hypotheses and plan next iteration
- Prompted a fundamental rethink of net-to-gross and permeability log interpretations
Appraisal Insights Application

- Improved shape but poor late-time match
- Need to further fine-tune parameter distributions
- Initial runs showed uncertainty range too narrow

Iteration 2

Iteration 4

Well data

Iteration 7

Iteration 15
Oil Field Development Application

Objective: reserves update for oil field development with production data

- Two hours to complete full iteration of 300 unique reservoir models with forecasts
- Fully linked static and dynamic QC with production data calibration for model falsification
- 75% reduction in model cycle time
Oil Field Development Application
Conclusions

• DELFI’s openness allowed for a fundamental reframe of the reservoir modelling process, with a strong focus on automation, speed and data management.

• Applied to greenfield, appraisal and brownfield applications with significant improvement in model cycle times, collaboration between disciplines and better uncertainty range quantification.

• Access to APIs and cloud compute can streamline workflows to get almost real-time results from modelling studies.

• Removing manual and siloed work allows subsurface professionals more time to collaborate, to explore, and to improve development outcomes.
Special Thanks

Thank you to Steve Freeman and everyone at SIS Perth, Leeds, Abingdon and Oslo.